

rior to the compass of mathematicians, we had one made which differs, in certain respects, from the one which is represented in the English review. We find in all the recent treatises on physiology, tables indicating for the diverse parts of the body, in its normal state, the limits where we begin, and where we cease to feel the two points of the compass, (according as they are brought near or widened.)

ARTICLE IX.

*On the Variations of Color in the Venous Blood of the Glandular Organs, according as they are in a state of Functional Activity, or of Repose.* By Professor CLAUDE BERNARD. Translated from the "*Journal de la Physiologie de l'homme et des animaux.*" By FRANK DOZIER, of Williamsburg, So. Ca., Student of Medicine in Oglethorpe Medical College.

Since the discovery of the circulation, two kinds of blood have been recognized: the one, *red*, or arterial, the other, *black*, or venous. This difference in color between arterial and venous blood, has been considered so characteristic that it has served as a base, since Bichat, to the anatomical division of the circulatory organs. "I divide, says this anatomist, the circulation into two—the one carries the blood from the lungs to all parts of the body, the other returns it from these parts to the lungs. The first is the circulation of red blood, the second that of black blood" (1).

The facts which I will have the honor of presenting to the Academy, will show that, hereafter, the two expressions *venous blood* and *black blood*, are no more to be regarded as synonymous. For, indeed, there is, in its normal state, venous blood, which is as perfectly red as arterial blood; moreover, there is venous blood which is sometimes red and sometimes black. But that which will be most interesting to the physiologist is, to learn that these variations in color,

(1). *Bichat*, Anatomie Generale, t. 11, p. 245.

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of the venous blood, correspond to different determined functional conditions of the organs.

Several years ago, (in 1845,) in making some experiments with dogs, on the elimination of some substances by the kidneys, I was surprised to see the blood which issued from this organ, by the vein, as red as that which entered by the artery. This rutilant color of the renal vein, was the more easy of being verified, as it showed distinctly upon the black blood of the inferior vena cava, in which it inosculates.

Recently, in my lectures before the College of France, I have resumed this first observation, for the purpose of discussing it more at length. I have had the same phenomena presented to me in the rabbit, as observed in the dog: viz: the renal veins containing red blood, mingling itself visibly with the black blood of the inferior vena cava. The lumbar veins, which empty themselves near the renal veins, contain *per contra*, black blood, like a small muscular vein which throws itself into the left renal vein.

Nevertheless, in multiplying my experiments on the dog and rabbit, and by varying the conditions of my observations, I soon perceived that this habitual redish color of the renal vein, could change its tint, and even become perfectly black, under the influence of diverse circumstances. Thus contradiction would here again find its place, if we had confined ourselves to the statement of a single result of the observation. Unfortunately, this can almost always be the case in physiology, when we do not distinguish with sufficient care among phenomena so complex as those presented by the eminently variable conditions of all living organisms.

After having established the two possible appearances of the blood of the renal vein, the thought suggested itself to my mind, to ascertain what relation they had with the functional condition of the kidneys. For this purpose, we placed a small silver tube in the urethra, through which the urine passed, drop by drop, without discontinuing. We remarked then, that the blood of the renal vein, as well as the tissue of the kidney, were perfectly rutilant while the urine flowed abundantly through the tube, but that this flow ceased to

*not present a black rutilant*  
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take place, under the influence of the circumstances, which, by blackening the blood in the renal vein, gave at the same time, a bluish tint to the organ. Whence it seemed to result, that the rutilant color of the renal vein was to be ascribed to the functional activity of the kidney, and its black color to the state of repose or inactivity of that organ. We saw also, that the re-action of the urine did not change at all the phenomenon: the renal vein is equally red in the dog, whose urine is acid, and in the rabbit, the urine of which is alkaline during digestion, and acid after 24 or 36 hours abstinence.

It would be useless for the moment, to enumerate all the influences which are capable of disturbing the formation of urine, and of causing a change in color of the renal veins. I will confine myself to the indication of the disturbing causes which relate to the operative process of the experiment, and I will say, that if it is desired to observe the rutilant color of the renal vein, we have simply to open the abdomen largely and throw aside the intestines, to bring the kidneys and their veins in view. An operation so grave, occasions almost always with the dog and with the rabbit, if not immediately, at least after very few moments, suppression of the urine (1), and we then see the blood of the renal veins assume a dark color, and often becomes as black as that of the inferior vena cava. Proceeding with the operation, the next step consists in making a small wound in the lumbar region, as for the operation of nephrotomy. It is preferable to operate on the left side, because, as the renal vein on this side is longer than that on the right side, it is easier to see it. Through the same wound, we may then isolate the urethra to place in it a silver tube, thus to assure us if during the observation, the urinary apparatus acts or not.

From all that precedes, it results clearly therefore, that

(1). In man, pain and the moral emotions, also often prohibit the formation of urine. M. Jobert, de Lamballe, has reported in his *Chirurgie Plastique*, cases of operation for vesico-vaginal fistular, in which (resulting from the emotions,) the flow of urine had been suspended during the entire time of the operation and for sometime afterwards

the blood of the renal vein, presenting a color habitually rutilant during the formation of urine, which is almost continual, does not enter any longer into the definition of venous blood, of which we have spoken above.

The first question which presented itself to the mind after the preceding observations, was to know if this rutilant color of the venous blood was an isolated fact peculiar to the kidney, or whether there was sufficient reason to suppose that it extended to other secretory organs, which have also the function of separating in their tissues, a special organic liquid. To verify this idea, I had recourse to the sub-maxillary gland of the dog, who is well suited to this examination. It constitutes in effect, an isolated organ, and so superficial as to be easily attained. I thus searched for the vein of this gland, and ascertained that it presented numerous anatomical variations (1), which could not modify in any respect, the observation of the physiological phenomena.

In my first experiment, which was made on the 28th December last, during my lectures before the College of France, I ascertained that the venous blood which came from the submaxillary gland, was as dark as the blackest venous blood. Nevertheless, this was by no means in contradiction with the redish color observed in the renal vein; for the salivary secretion is intermittent, and the gland did not secrete at the moment when we ascertained the presence of black blood in its vein. It was requisite for us to know then, that if we caused the sub-maxillary gland to secrete, we would see a change of color in its venous blood. For this purpose, we put a few drops of vinegar into the mouth of the animal, which induced, by reflex action, the salivary secretion. We then saw plainly verified, the previsions which we had had; for, after some moments, the color of the blood changed its tint in the vein of the gland, and that which was black became quickly redish, but returned after

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(1). Sometimes the glandular vein is single, and emerges from the posterior part of the gland, emptying its contents into the sub-maxillary vein; sometimes it has two origins or two branches, of equal or unequal volume, flowing into two distinct venous trunks, after passing over a greater or less distance, etc.



a short while to its black color when the secretion ceased (1).

In order that no doubt may exist as to the interpretation of the phenomena observed by us, we exposed the excretory duct of the sub-maxillary gland, and introduced into it a small silver tube; after which, we isolated the nervous branch which the lingual nerve gives to the gland. We had then presented to view, the vein of the sub-maxillary gland, its excretory duct, in which was placed a tube, and the excitatory nerve of secretion. We then observed that whilst the organ was in a state of repose, nothing issued from the tube, and that black blood circulated in the vein of the gland; whereas, upon each excitation of the nerve of the gland by galvanism, thus establishing the secretion, the color of the venous blood appeared red, but became black again, as soon as the excitation ceased and the secretion arrested. We repeated, at different times, the same proof, with similar results. We observed, besides, that there was always an interval of several seconds, between the excitation and the appearance of the secreted liquid, and the red color of the blood. The latter arrived more slowly, as if a certain time was required for the gland to empty itself of the black blood which it contained, before the red blood could appear. Reasoning from analogy, it undoubtedly happened also, that the red color of the vein persisted always for several moments after the cessation of the secretion; or, in other words, it was always in a gradual manner that the red color of the blood was changed to black, or reciprocally. Finally, we observed also that the blood flowed always more abundantly when it was red, that is to say, when the organ was acting, than when it was black, the organ being in repose.

Lately, this experiment on the sub-maxillary gland, has been repeated several times upon dogs, always with similar results, excepting some differences in the intensity of the phenomena, probably owing to the *vigorous* or *enfeebled* condition of the animals (2).

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(1). At the same time, we saw small veins, coming from the mucous membrane of the mouth, containing also many glandules, assume a very evidently redish color.

(2). The results are in general much more clear and rapid, when the animal is

The observations on the sub-maxillary gland show thus, that its venous blood is alternately black or red, and that these alternations in color of the venous blood correspond exactly to the intermittence of the functions of the gland.

The two series of results which we have reported and obtained, the one on the kidney and the other on the sub-maxillary gland, certainly do not constitute isolated facts; and the same observation will no doubt extend to other glands. The experiments which I have commenced on the parotids and on the abdominal portion of the digestive tube, have furnished me, thus far, results generally the same; however, the study will only be completed, when these experimental researches will have been made, on each gland in particular.

To resume, it results from the facts contained in this article that if in the physiological state we have to preserve the qualification of red blood for arterial blood, (which is properly speaking, but the venous blood of the lungs,) black blood can not be maintained generally for venous blood. We have proved in fact, that the venous blood may be *red* or *black* in secretory organs, according as we consider them in a state of functional action or of repose. This consideration of the activity and repose of the organ, which correspond in some measure to its static and dynamic conditions, appears to me to constitute an important point, to be introduced into the study of the physiology and chemical properties of the blood. In fact, it is not only in color that the venous blood of an organ in repose, differs from the venous blood of that organ while in action; but it presents still other important differential characteristics, which are owing to a profound difference in the chemical constitution. Thus it is that the venous blood which is rutilant when the kidney is in action, remains more diffuent and

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most vigorous, and when the organ has been less fatigued by previous excitement, or by exposure to the air. It sometimes happens also, that the vein becomes so dry and hard, as to embarrass the circulation; then it is necessary to cut it at its exit from the gland, to be able to judge directly, of the color of the blood which issues from it.



sometimes even presents no clot; whilst the blood of the same vein, when the kidney ceases to act, is black, and offers a clot of considerable consistency, etc.

Without doubt, the physiologist and the chemist had already ascertained that venous blood could not, like arterial blood, be regarded as everywhere identical, and that it was necessary to analyse the venous blood of each organ in particular; but that which they have never mentioned, I think, and which seems to me, nevertheless indispensable to future considerations, if they wish the chemical analyses to conduct to facts as useful as possible to physiology; is to examine *separately* and *comparatively*, the composition and the properties of the venous blood of an organ, when in the performance of its functions and when in repose. We can, from what we have said above, predict that *greater differences* will be often found in the blood, which circulates in the same organ when in a state of functional activity and when in repose, than between the corresponding blood of two different organs.

This statement does not apply to the glands alone, but will embrace all the organs of the body, the venous blood of which it will be necessary to study now, at the times of their repose, and functional activity. We can as it were, *characterise each tissue*, by the very diverse modifications impressed upon the blood, by its proper functional action. Thus it is, that if the blood issues red from the gland, while it is in action, it comes, on the contrary, very black and with different physical qualities, from a muscle which is contracted. The mechanism of these varied colors of the blood, will necessarily find its explanation in subsequent chemical analyses, of which we have only indicated for the present, the physiological conditions.

We close with one remark: it is that all the modifications which occur in the blood, in consequence of the functional activity of the organ, are always determined by the nervous system. It is consequently in this point of contact, between the organic tissues and the blood, where we must look for the idea, which it becomes us to entertain of

the special character of the nervous system, in the physico-chemical phenomena of life. The development of the facts, which are connected with this general physiological point, will be the object of a future communication.

### EXPERIMENTS (1).

EXP. I. On a large and very vigorous dog, during digestion, we laid bare the sub-maxillary gland, by dissection and by removing with precaution the digastric muscle; we discovered the salivary duct and introduced a tube into it; we isolated and ligated the glandular filament, coming from the lingual; lastly, we looked for the vein of the gland and cut it; the blood which escaped from it was black. All being thus prepared, and the animal remaining exceedingly calm, we galvanized the nervous filament with Breton's machine. Immediately the saliva issued from the tube, the venous blood of the gland became rutilant; it escaped in a *greater quantity, and presented a very decided jerking motion*. We collected this redish venous blood and compared it with some arterial blood taken from a neighboring artery. They both had at first sight, the same vermilion tint. But, after a little while, the venous blood, which was red, became black; whilst the true arterial blood, maintained for a length of time, its primitive color. After discontinuing the galvanism, the saliva ceased to flow; the blood of the gland returned to its original appearance; it is black and flows in a uniform manner.

We left the animal to repose, and afterwards resumed the experiment with the same results. As long as the saliva flows, the blood which comes from the gland is red, flowing in a larger quantity and by jerks.

EXP. II. On a dog we prepared the maxillary gland in the same way as shown in the preceding experiment. The venous blood which comes from the gland is black, when the organ

(1). The details of these experiments, which M. Bernard has been pleased to furnish us, for adding to his communication to the Academy, are full of interest. We call particular attention to the third experiment, which contains the indication of new facts, which merit as much as those which M. Bernard has already made known, the careful attention of physiologists.



is in repose; it becomes red and flows in greater abundance, when we galvanize the filament coming from the lingual, and when we provoke thus the salivary secretion.

We cut the sympathetic filament which passes into the gland in company with its artery; the venous blood becomes red, and there was no salivary secretion. We galvanized this filament; the blood of the gland became black, and flowed in less quantities. We ceased the galvanism, the blood became again red; we re-applied it, and the blood became black.

EXP. III. On a dog, during digestion, we laid bare the sub-maxillary gland, by removing the digastric muscle. We isolated the two nerves of the gland, we introduced a tube into its duct; lastly we looked for the vein and cut it; the blood which it contains is black.

We ligated the glandular filament coming from the great sympathetic; the venous blood of the gland became redder, and flowed more abundantly, there was no saliva excreted; we galvanized the sympathetic filament; the blood of the gland became perfectly black, flowing in a smaller quantity, and finally ceased entirely. We left the animal to repose; the blood of the gland became again red. We tied the glandular filament coming from the lingual, and galvanized it; the saliva flowed profusely, the venous blood maintained the same rutilant color which it already had, but it flowed in a greater quantity, and presented a jerking motion, synchronus with the pulse.

We left the animal to repose, after which we galvanized the sympathetic filament; the phenomena which we have mentioned were again produced, but more slowly.

After another repose, we galvanized the filament coming from the facial nerve. The saliva flowed abundantly, and the venous blood, of a fine rutilant color, issued by jerks and was projected to some distance.

## Editorial.

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"The appearance of a Journal upon our table, is not unlike the receipt of a letter from a friend, in which congeniality of thought strikes an answering chord, or a sentiment advanced awakens thought and prompts investigation. For ourself, we never read an editorial without experiencing a desire to know *whose* thoughts are addressing us, and, in the absence of this knowledge, we fail to derive a full degree of satisfaction. We regret that some of our editorial brethren choose to retire behind a signature which completely shrouds their individuality. We assure them that we would much prefer to know them more intimately. Will they not append their *initials* to their articles?"—*Peninsular and Independent Med. Journal*.

In answer to similar requests, from several subscribers, to that quoted above from our cotemporary, we mentioned in our last Number, that "articles coming under the Review and Editorial Departments of the Journal, from others than the Senior Editor, will be designated by the *initials* of the writer, all *other* articles under *either* of those heads, not thus designated, are from his pen." But, as that notice may not have been generally observed, we will adopt the plan suggested by our cotemporary, and append our initials to our articles.

We must mention, as an act of justice to our worthy *confrere*, that he has been so circumstanced since the commencement of the Journal, as not to be able to furnish us with editorial matter thus far—his residence, for the period mentioned, having been at Jacksonville, Florida—but we venture to assure our readers, that he will give a good account of himself, on his return to this city, next November. If he cannot render much assistance, editorially, now, his pen will not remain idle in the cause of our profession.

H. L. B.

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### SPECIAL NOTICE.

*Exchanges, Publishers, and others*, will confer a special favor by being *certain* to address *all* their favors intended for us, to "Oglethorpe Medical and Surgical Journal," Savannah, Ga. This notice becomes necessary, in as much as another Journal has been started in this city, in no way connected with ours. Papers with which we exchange, and which were intended for us, have, in some instances been addressed merely to